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Multidecadal Cloud Variabilty and Climate Change in Observations and CMIP5

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Abstract: Cloudiness plays a key role in the climate system due to its large radiative impact, but it is currently not known how clouds will change with global warming. Several key uncertainties noted by the IPCC AR4 are: 1) how cloud cover has changed during the past several decades of surface and satellite observations, 2) how cloud cover is projected to change with increasing greenhouse gas concentrations in climate models, and 3) the sign and magnitude of cloud feedback on climate. There are several reasons why answers to these critical questions are unknown. Satellite cloud records suffer from inhomogeneities due to insufficient calibration, orbital drift, sensor degradation, etc. These problems are currently so bad that decadal variability in the observational record is predominantly spurious. The surface cloud record from ICOADS exhibits a suspicious spatially uniform increase in cloud cover over almost the entire ocean, but the origin of this apparent artifact is not known. Because AR4 global climate models incorrectly and inconsistently simulated cloudiness, exhibited severe biases, and produced cloud trends of differing signs across different models, it was difficult to produce a credible projection of expected cloud changes in future decades.

In the proposed project, we will use cluster techniques to identify artifacts in the ISCCP satellite cloud dataset. Satellite view angle and geostationary calibration artifacts will be empirically removed by appropriate linear regression. A newly calibrated and newly processed ISCCP dataset will become available in the next year, and it is expected that physically-based recalibration of ISCCP will provide even better results. We will determine whether artifacts remain in the new ISCCP, and if so, apply empirical adjustments to remove them. The diurnal cycle of cloud from ISCCP will be used to physically correct the PATMOS-x satellite cloud dataset for the effects of orbital drifts through local time that aliased the diurnal cycle into longterm trends. We will also investigate and remove artifacts in ICOADS surface cloud reports to extend the observational record into the pre-satellite era. Our goal is to obtain three independent and homogenized cloud datasets derived from ISCCP, PATMOS-x, and ICOADS that will provide a reliable measure, including an uncertainty range, of long-term variability in global and regional cloudiness during the past several decades. These datasets will be archived for use by the general community.

Our homogenized cloud record will then be used to investigate multidecadal cloud variability from the new and improved generation of global climate models in CMIP5. We will examine projected 21st century CMIP5 cloud changes that are common across many models to see if they are consistent with plausible projected meteorological changes (and therefore more likely to be robust). Observed cloud changes that resemble projected cloud changes may be attributed to anthropogenic global warming if they rise above the level of natural variability suggested by the

models and observations. Our plan is to finish the research and publish our results in time to be included in the upcoming IPCC AR5.